

A FLUENT LANGUAGE DISORDER FOLLOWING ANTEPARTUM LEFT-HEMISPHERE BRAIN INJURY

HEIDI M. FELDMAN, AUDREY L. HOLLAND¹
University of Pittsburgh

ROSALYN E. BROWN
Children's Hospital of Pittsburgh

This article describes the development of language in a left-handed girl with a left middle cerebral artery infarction. Seven language samples of parent-child interaction, obtained when she was between 36 and 60 months of age, were transcribed and analyzed using the Child Language Data Exchange System. At 36 months of age, only 42 (20%) of the child's 214 utterances contained words; the other 80% were composed of jargon or interactional markers such as "uh-huh" and "uhn-uhn." Jargon incorporated familiar intonational contours and prosodic features to convey emotional states and communicative functions. Between 36 and 45 months of age, her jargon became differentiated into increasing approximations of English sentences. Simultaneously, her use of words and word combinations increased. By 54 months of age, no jargon was heard. The pattern of development observed in this child can be described as a transient jargon or fluent aphasia. It may have resulted from initial reliance on an uninjured right hemisphere. However, given the similarity between this pattern and the expressive or gestalt style of learning seen in some normal children, the pattern may also be related to other variables including characteristics of the parental input.

INTRODUCTION

Aphasia in adults results from brain injuries to left cerebral hemisphere; selective language disturbances typically do not follow comparable injuries to the right hemisphere. These observations have formed the basis of the assertion that speech and language abilities are localized in the left hemisphere of the mature brain. Studies of children with early

¹ Present Affiliation: University of Arizona.

Address correspondence to Heidi Feldman, M.D., Ph.D., Child Development Unit, Children's Hospital of Pittsburgh, 3705 Fifth Avenue, Pittsburgh, PA 15213-2583.

brain injuries have reported that left-hemisphere injuries lead to greater impairments of language skills, particularly of syntactic abilities, than comparable right-hemisphere injuries (Aram, Ekelman, Rose, and Whitaker, 1985; Aram, Ekelman, and Whitaker, 1986; Kiessling, Denckla, and Carlton, 1983; Rankin, Aram, and Horowitz, 1981). These studies have led to claims that the left hemisphere is specialized for speech and language very early in life, possibly even at birth, before any language learning has commenced. Brain injuries sustained early in life typically cause less severe language disruptions than similar lesions sustained after childhood. The resilience of the developing brain after injury, through recovery of function and continued development, has been called plasticity.

Clues about the neural mechanisms of plasticity as well as the neural substrate of normal language development can sometimes be inferred from studies of developmental patterns after brain injury (Feldman, Holland, Kemp, and Janosky, 1992; Goldman, 1974). Several studies have found that children with perinatal brain injuries to either hemisphere show initial developmental delays in language acquisition (Basser, 1962; Feldman et al., 1992; Marchman, Miller, and Bates, 1991; Thal, Marchman, Stiles, Trauner, Nass, and Bates, 1991). Delays have been documented in the onset of babbling (Marchman et al., 1991), the acquisition of vocabulary (Feldman et al., 1992; Marchman et al., 1991; Thal et al., 1991), and early development of syntax (Feldman et al., 1992). These findings suggest that initial stages of communicative development may depend on regions of both cerebral hemispheres such that damage to either hemisphere results in developmental delays. After initial delays, the rate of developmental change in some children with brain injuries has been found to approach normal (Feldman et al., 1992; Thal et al., 1991). These findings suggest that once the recruitment and organization of undamaged neural substrate is accomplished, even if the substrate does not serve language under routine circumstances, early stages of language acquisition may proceed at near normal rates.

Children with left-hemisphere injury, after recovery of function, typically produce shorter, syntactically less complex utterances than uninjured controls and children with right-hemisphere damage (Aram et al., 1986). The pattern of language abilities is reminiscent of a nonfluent or Broca's aphasia in adults with left frontal lesions, though the deficits may be too mild to be categorized as aphasia. Rarely do children with acquired brain injuries use jargon, paraphasia, or neologisms, as do adults with fluent or Wernicke's aphasia. In a review of 65 cases, Woods and Teuber (1978) found one subject, a 5-year-old boy, who used nonmeaningful jargon immediately after a left middle cerebral artery infarction. The child recovered age appropriate speech and lan-

guage skills by 9 months subsequent to the injury but had persistent deficits in short-term verbal memory, comprehension of complex verbal directions, and naming. VanDongen, Loonen, and VanDongen (1985) identified three girls who had fluent paraphasic speech from a clinical sample of 27 children with aphasia. All three girls had focal injuries to the left posterior temporal lobe, similar to the location of injury in adults with Wernicke's aphasia. Two of the girls showed resolution of the fluent aphasia within weeks of the injury; the third child's condition deteriorated after the onset of seizures.

This is the first report of what could be aptly called a transient fluent or jargon aphasia in a child with a congenital left-hemisphere brain injury. When first observed at age 3, the girl produced primarily jargon and phonemically undifferentiated interactional markers. Over the next 12-month period, as she slowly acquired standard English vocabulary as well as the capability to combine words into sentences, the jargon aphasia gradually resolved. We describe her developmental course in detail because her pattern of development may have resulted from initial reliance on the right hemisphere during the early phases of communicative development.

The pattern we observed in this child with left-hemisphere brain injury was reminiscent of a style of language learning that has been called "expressive" or "gestalt" and that characterizes some children who are free of neurological injury (Nelson, 1973; Snyder, Bates, and Bretherton, 1981). The presence of these similarities suggests that variables other than the location of brain injury may also influence the developmental pattern. One such variable is the nature of the linguistic environment. Parental emphasis on labeling of objects has been associated with a predominance of nouns in the child's early vocabulary, a style called "referential" or "analytic." Parental emphasis on social routines has been associated with the expressive or gestalt style (Goldfield, 1987; Goldfield and Resnick, 1990; Nelson, 1973). In this case, the parental input to the child emphasized social exchange over object talk and may have served as a contribution to the use of jargon for social exchange.

METHODS

Subject

The primary subject for this report was drawn from a cohort of 66 children referred by local physicians to a study on language and cognition after antepartum and perinatal nonprogressive brain injury. Of the cohort, 9 children to date have had left-hemisphere lesions, and one of them had a left middle cerebral artery infarction. Maggie, as we will

refer to her (based on the three-letter code name MAG that will refer to her in the data base of the Child Language Data Exchange System: MacWhinney, 1991), was the third child born to an upper middle class family. Her father was a right-handed stockbroker, her mother a right-handed college-educated homemaker. Maggie was initially evaluated by a child neurologist at 3 months of age because of motor delays. During infancy she developed a decided left-hand preference and was diagnosed as having a right hemiparesis. A CT scan obtained when she was 14 months of age revealed a large focal lesion in the distribution of the left middle cerebral artery (Figure 1). The lesion was presumed to have occurred in the antepartum period because there were no complications during labor, delivery, or early postnatal life. Between 6 months and 3 years of age, the hemiparesis gradually resolved but the child remained left-handed. She showed no oral-motor dysfunction. However, she showed extreme delays in speech and language skills. She was enrolled in speech and language therapy at 24 months of age because she was completely nonverbal and minimally communicative. Vocal communication and initial vocabulary development, by report, began after she turned 30 months of age.

Standardized testing was completed at each birthday. At 36 months of age she was evaluated using the Battelle Inventory (Newborg, Stock, and Wnek, 1984); she achieved a standard score of 72 on the cognitive scale, almost 2 standard deviations below the mean of 100. On the Sequenced Inventory of Communicative Development (SICD: Hendrick, Prather, and Tobin, 1975) at 36 months of age, she achieved a receptive age equivalent of 24 months and an expressive age equivalent of 20 months; on the Peabody Picture Vocabulary Test (PPVT: Dunn and Dunn, 1981) she earned a standard score of 83. Her scores on cognitive testing improved over the next two years. The General Cognitive Index (standard score) on the McCarthy Scales of Children's Abilities (McCarthy, 1972) was 87 at 48 months of age and 102 at 60 months of age. At 48 months of age she achieved a standard score of 103 on the PPVT and at 60 months of age she scored 102 on the same measure. At age 6 she was evaluated using the Comprehensive Evaluation of Language Function—Revised (CELF-R: Semel, Wiig, and Secord, 1987). Her standard score on the receptive scale was 87 and on the expressive scale was 78. The subtests in which she showed deficits were comprehension of oral directions and sentence formulation using specific lexical items. Academic skills at age 6 were appropriate for late kindergarten.

In order to characterize the nature of the parental input that Maggie received, we compared Maggie's mother to 2 other mothers of children in the study population. These families were chosen because the child



RIGHT

LEFT

Figure 1. CT Scan of Maggie. Note left-sided damage.

subject was a girl with an antepartum or perinatal brain injury, second or third born, in families who were upper middle class, and whose mothers were college-educated full-time homemakers. The names of these children are based on their three-letter code name in the Child Language Data Exchange System (MacWhinney, 1991). Blanche (BLA) had focal right-hemisphere injury and developmental delays in cognition and language; Grace (GRA) had left-hemisphere injury and mild right hemiparesis but no developmental delays except in motor skills. Two ages were selected for the comparison, the oldest age at which the child used single words and no word combinations, comparable to Maggie's stage of development at 36 months of age, and the chronological age matched within 3 months to Maggie at the first visit.

Procedures

Seven language samples, each lasting approximately 30 minutes, were obtained when Maggie was between 36 and 60 months of age. Language samples were generated from parent-child interaction. In the first two sessions, both parents participated, but the mother offered greater input than the father; in subsequent visits only the mother participated. The interaction was divided into 5 activities, structured by the materials provided: warm-up play with small human figures and a tea set, ball play, reading, coloring, and a busy book with fasteners and hidden objects. Procedures are described in detail in Feldman et al. (1992).

Transcription. Language samples were transcribed directly from both audiotape and videotape to an IBM computer by trained research assistants using the Child Language Data Exchange System (CHILDES; MacWhinney, 1991). Phonetic transcription used the ASCII translation of IPA symbols as described by MacWhinney (1991).

Reliability. The entire transcripts of the first five visits were reviewed by two investigators working together in order to assure that jargon was properly categorized. Disagreements were discussed until total agreement on transcription and coding was achieved. Twenty percent of the final two visits were reviewed by a second transcriber. Interobserver reliability on these two tapes was greater than 90%.

Definitions and Measures. Utterances were defined as vocal or verbal output terminating in rising or falling intonation or a long pause. Words were defined as invariant forms used in predictable contexts, even if the forms did not conform to standard English. For example, Maggie used /bI na/ to refer to a banana. This form was considered a

word because it conveyed a consistent meaning. Jargon was defined as vocal forms that bore no resemblance to standard English words and that did not vary phonetically in relationship to the context. Interactional markers were conventional undifferentiated phonological forms that served a communicative function (MacWhinney, 1991). Examples included "huh?" for clarification, "uh-huh" for agreement, and "uhn-uhn" for refusal or rejection. Utterances composed of jargon and/or interactional markers plus words were labeled mixed forms and have also been referred to as mature jargon (Capute, Palmer, Shapiro, Wachtel, Schmidt, and Ross, 1986). The term "sentences" was restricted to utterances composed entirely of words, either single words or word combinations that included no jargon or interactional markers.

The following measures of Maggie's communication were generated from the transcripts: (a) total number of utterances; (b) number of different words (lexical types); (c) number of total words (lexical tokens); (d) number of utterances composed entirely of jargon; (e) number of utterances composed entirely of interactional markers; (f) number of mixed forms; (g) the number of sentences; (h) the number of verbs, adjectives, and adverbs (tokens); and (i) the mean length of utterances (MLU). MLU, a direct measure of sentence length, was used as the index of sentence complexity because sentence length and syntactic complexity are highly correlated in young children (Brown, 1973). The measure is calculated by dividing the number of morphemes by the number of utterances (Miller, 1981).

The measures of maternal input included (a) total number of utterances during warm-up play, (b) the proportion of questions, including intonational and tagged forms as well as *wh*-questions, and (c) the proportion of lexical tokens that were nouns.

RESULTS

Evidence of a Fluent Language Disorder

During the session at 36 months of age, Maggie produced 214 utterances. Vocalizations were clearly communicative. They were frequently directed to one or the other parent by changes in gaze and body position, and often accompanied by exaggerated facial expressions, elaborate gestures, and occasional use of sign language that was being taught in speech-language therapy. Some utterances were spontaneous; others occurred in response to parental requests and questions.

The vast majority of utterances (80%) did not carry clear referential

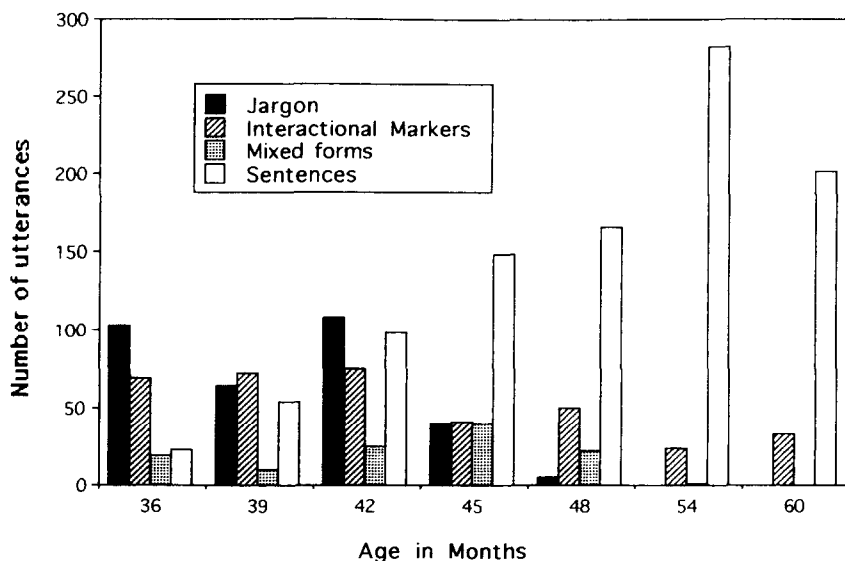


Figure 2. Number of utterances composed of jargon alone, interactional markers alone, mixed forms (jargon or interactional markers plus words), and sentences (words alone or in word-word combinations).

meaning. Of the total, 103 utterances (48%) were jargon (Figure 2); 69 utterances (32%) were interactional markers. In this category we also included infrequent examples of onomatopoeia, such as slurping sounds used to communicate about the act of drinking.

Maggie typically used rich and textured intonational contours with jargon and interactional markers. She used both rising and falling intonation at the terminal portion of the utterance, reminiscent of questions and statements. Some jargon had the rhythm and intonation contour of conventional social exchanges, such as "thank you" and "I don't know." Other prosodic features such as loudness and emphasis conveyed a range of emotional states from pleasure to annoyance and anger. She used jargon and interactional markers in a variety of communicative exchanges to make requests and comments, and to indicate agreement, disagreement, and refusal.

Maggie produced only six lexical types during the first visit. The words were characteristic of the vocabulary of children just beginning language acquisition: mom, dad, bye-bye, look (pronounced without the initial l), here (pronounced /ha/), and hot. Words were used alone or in combination with jargon or interactional markers in 42 (20%) of the utterances. All of the sentences at this age were one-word utterances.

The phonological repertoire revealed minimal overlap between jargon and words. Jargon typically used the consonants (/d/ or /l/ and the open vowels /a/ and /ə/. The /m/, /b/, /h/, and /k/ found in her conventional words were rare in the jargon; /l/, a typically late-evolving consonant, was present in the jargon but was not present in any words. Some of the jargon seemed dysfluent; dysarthria was not noted.

Development of Vocabulary

Maggie's lexicon developed gradually. At 39 months of age, the number of lexical types obtained in the sample increased from 6 to 10 and the number of lexical tokens, used alone or in combinations, increased to 64 (32%) of 270 utterances. The number of lexical types per sessions increased steadily up to 54 months of age. Table 1 includes total number of types, tokens, and the number of nouns, verbs, and modifiers (adjectives and adverbs) at each visit. The composition of the vocabulary up to age 42 months contained nouns and words to regulate social exchange (e.g., look, no, more). Maggie began to use verbs and modifiers such as color and number words at 45 months of age when the size of her lexicon showed a dramatic increase. Figure 3 demonstrates that the proportion of utterances that included words also increased up to 54 months of age, when it reached a plateau.

Development of Sentences

Two distinct processes characterized the development of sentences. The first was differentiation of long strings of jargon. Between 42 and 48 months of age, Maggie produced several mixed forms, utterances that integrated words with either jargon or interactional markers. The typical mixed form began with jargon and ended with a recognizable word. For example, at 36 months of age Maggie uttered /ənə dədə/ (...dada); at 42 months, she said /nΛ na az/ (...orange). There were also examples of mixed forms with conventional words at the beginning and jargon at the end.

At 48 months of age, we observed examples of progressive differentiation of mixed forms across adjacent utterances. The examples below are presented phonetically with the conventional lexical type provided in the parentheses:

Maggie: /ə ni kəla/ (...need color)

Mother: what?

Maggie: /ni, ni dI kəla/ (need, need this color)

Table 1. Measures of Maggie's Lexical and Syntactic Development

Measures	Age (months)						
	36	39	42	45	48	54	60
Types	6	10	18	65	118	195	190
Tokens	43	65	66	216	364	637	401
Number of verbs	1	0	1	25	71	106	53
(tokens)							
Number of adjectives and adverbs (tokens)	2	2	5	68	63	129	65
MLU	1.00	1.05	1.19	1.18	2.26	2.85	2.26
Examples of word combinations	No mum.	No mum.	Want some. Bye-bye daddy.	No girl.	That a pink. Who drink this pop? (Be)cause I done.	I not know how to put it. My head's big. Here's banana too.	You don't know what this fits on? A bunny's playing with a choo-choo train. I know what's in there.

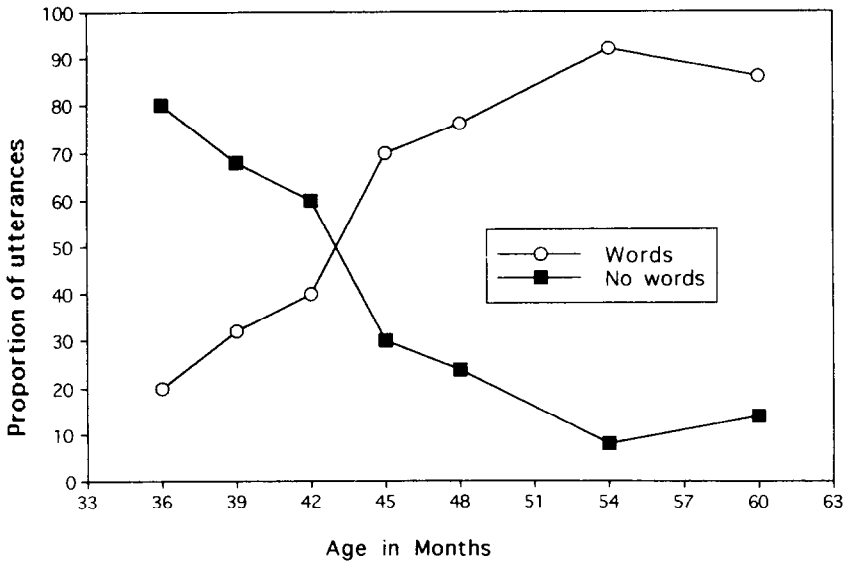


Figure 3. Proportion of Maggie's utterances containing any words versus non-words only.

Maggie: /aI ən səsə/ (I...)
 Mother: pardon me?
 Maggie: /ai mek nem/ (I make name)

The second process involved in the development of sentences was concatenation of words. Table 1 lists the MLU values obtained at each session and representative utterances. Word combinations were first heard at 42 months of age. A substantial increase in MLU occurred between 45 and 48 months of age. During this same period, the proportion of utterances with nonwords steadily declined (Figure 3). In this age range we also noted a reduction in the number of dysfluencies.

Parental Input

Maggie's parents were attentive and responsive to their child during our sessions. Their utterances were characterized by questions rather than statements or commands. The function of the questions was predominantly to continue the social exchange either by requesting clarification of her meaning or asking her preference for activities. The parents rarely commented on objects in the world or provided the conventional name for a toy she was holding; they did not expand her

utterances nor their own previous utterances. A typical example from the transcript is as follows:

- Mother: wanna look in here?
 Mother: see what you see?
 Mother: what-'is that?
 Maggie: (picks up a bell and tries to ring it)
 Mother: (Mother picks up the bell and rings it, without verbalizing)
 Maggie: /wa du/. (jargon)
 Mother: whoops.
 Mother: what else do you see?
 Mother: you know who this is? (holding up a puppet)
 Mother: who-'is this?
 Mother: Maggie, Maggie.
 Maggie: (looking in the toy bag; finds a lid and tries to put it on the tea cup)
 Mother: I do-'nt think it-'s this one, maybe those. (Mother tries to fit the lid on the tea pot)
 Mother: too big, huh?
 Maggie: /dII dIA/. (jargon)
 Mother: can you find Bert?

Table 2 compares Maggie's mother to two other mothers participating in the study. The table demonstrates that all the mothers used a comparable number of utterances and had similar MLUs when their children used one-word utterances. As suggested by the transcript, Maggie's mother used more questions and fewer nouns than the other mothers did with their daughters at initial stages of language development. Maggie's mother style was consistent across the first two observations, when Maggie's MLU remained less than 1.05. A low proportion of nouns was also observed in Grace's mother when she was 33 months of age; at this time the child had an MLU of 4.27 and her mother was using more adjectives and adverbs than typically seen in the communication aimed at young language learners.

DISCUSSION

Maggie, a child with a discrete, focal lesion in the distribution of the left middle cerebral artery, sustained presumably in the antepartum period, was extremely delayed in the onset of language. Many characteristics of her communication have been described in other children with early brain injuries: limited phonemic diversity (Marchman et al., 1991), small vocabulary (Thal et al., 1991), and short sentences (Aram

Table 2. Characteristics of Maternal Input to Child

	Name					
	Maggie		Blanche		Grace	
	<i>Child</i>					
Age (months)	36	39	27	33	15	33
MLU	1.00	1.03	1.00	1.45	1.05	4.27
	<i>Mother</i>					
<i>Number of utterances in warm-up play</i>	<i>103</i>	<i>107</i>	<i>98</i>	<i>77</i>	<i>127</i>	<i>66</i>
MLU	3.864	3.757	3.990	4.000	4.126	5.303
Proportion of questions in corpus	75	71	34	13	57	36
Proportion of nouns in lexicon	12	10	19	14	17	9

et al., 1986). However, the most striking characteristic of her early communication was a period of heavy reliance on jargon and interactional markers. Between ages 3 and 4 she was extremely communicative but used few words and word combinations. She conveyed a range of emotional states and communicative exchanges through jargon and interactional markers, accompanied by a range of intonational patterns, prosodic features, facial expressions, and gestures. This language pattern could be described as a transient fluent or jargon aphasia. We have observed other children who have used babble and jargon prior to use of conventional vocabulary. However, the degree of language delay and of reliance on jargon was more extreme in this child than any of the other subjects.

Maggie's pattern of language development was similar to the recovery patterns of other children with fluent or jargon aphasia described in the literature (VanDongen et al., 1985; Woods and Teuber, 1978). Like the other children, the period of jargon aphasia was transient. During the phase of jargon aphasia, language comprehension was less severely impaired than language production, as demonstrated in Maggie's case by higher scores on the receptive than expressive scales of the SICD. Subsequent to the period of jargon aphasia, the children reported in the literature had residual deficits in short-term verbal mem-

ory, comprehension of complex oral directions, and naming or word finding (VanDongen et al., 1985; Woods and Teuber, 1978). On testing using the CELF-R at age 6, Maggie showed persistent problems with comprehension of complex oral directions and with formulating sentences using specified vocabulary. In addition, clinically she had a digit span of 3 and struggled with rapid confrontational naming.

What accounted for the transient period of jargon aphasia after left-hemisphere damage in this child? The injury in Maggie's case involved posterior regions of the left temporal lobe, the site of injury in the other reported children with fluent aphasia (VanDongen et al., 1985; Woods and Teuber, 1978). One hypothesis is that Maggie, like these other subjects, may have been relying on the right hemisphere for language abilities during the early developmental period. The right hemisphere has substantial capacity to understand language but has minimal abilities to produce language (Kinsbourne and Hiscock, 1983). The right hemisphere also seems to have a privileged role in understanding emotional and prosodic features of language (Blonger, Bowers, and Heilman, 1991). Given that her left hemisphere was severely injured, Maggie may have launched the development of language using the healthy brain regions of the right hemisphere, doing what that region does best, participating socially and expressing emotional states through the use of jargon rich with prosodic features.

Children with early left-hemisphere damage are typically nonfluent during recovery or early development (Aram et al., 1986; Woods and Teuber, 1978). The other child in our cohort with a similar large middle cerebral artery infarction that damaged the left posterior temporal lobe did not use jargon when we observed him between ages 2 and 4. However, by school age, he did show poor comprehension of oral directions, limited digit span, and word finding difficulties. Given that postrecovery language skills of children who have shown transient fluent aphasia have been similar to children who have shown nonfluent patterns, a further hypothesis is that recovery or development of vocabulary and syntax may indicate restoration of language abilities to uninjured regions of the left hemisphere. In the future, different methodologies such as PET scanning or electrophysiological techniques may be useful to determine whether language abilities after early injuries are served by the left or right hemisphere and whether the site changes over time.

One caution about this neurological explanation for a fluent language disorder after early brain injury is that Maggie's developmental pattern, though significantly delayed, was similar to one style of normal language learning called the "expressive" or "gestalt" style (Nelson, 1973; Nelson; 1981; Peters, 1983; Snyder, Bates, and Bretherton, 1981). Children described as expressive first acquire large and internally un-

processed units of language that foster social exchange rather than convey referential meaning. Maggie's communication was particularly reminiscent of one such child described in detail by Peters (1983). This normal child also used jargon heavily in the early stages of language development. The strategy for extracting features from the speech stream in both the normal and brain-injured child was apparently to note features of whole utterances and to remember them along with salient features of the situational context. Maggie had a propensity to pick up what Peters (1983) has called the "tunes" or "melodies" and the rhythmic patterns of stretches of speech. These melodies and rhythms were applied to phonemically limited jargon and undifferentiated interactional markers. Developmental progress involved differentiation of the jargon. Maggie first differentiated the ends of strings, and then the middle portions. Again, this strategy for segmentation was characteristic of the child described by Peters (1983), who also segmented off the first or the last syllable of a unit from the rest.

Maggie's reliance on jargon may have been related, at least in part, to factors experienced by children who are free of neurological damage. We suspect that the linguistic environment in which Maggie lived may have played a role in the development of her expressive learning style. She was a third-born child. Children who use this learning style frequently are not first born (Nelson, 1973). Her mother used a high proportion of questions rather than comments or commands and a low proportion of nouns in her input; her communication stressed social interaction over object play. Though her mother's linguistic input may in part have reflected her efforts to understand her daughter's jargon, it nonetheless provided fewer opportunities for learning nouns than the style of other parents of children at the earliest stages of language development. This type of parental input has been associated with the expressive language learning style in children without brain injuries (Goldfield, 1987; Goldfield and Resnick, 1990; Nelson, 1973).

Maggie's jargon aphasia, like the expressive style of language learning, may have been related to a combination of endogenous (child) factors and exogenous (environmental) factors. The presence of a left-hemisphere brain injury to the posterior temporal lobe may have been one predisposing factor to the developmental pattern. Given Maggie's left-hemisphere brain injuries, the melodies and rhythms may have been easier for her to produce with an intact right hemisphere and may have reflected the social and communicative functions of language for which the right hemisphere is specialized. However, the brain injury may be neither necessary nor sufficient to explain the developmental pattern. The style of parental input may have also been a factor in this child's development of expressive communication in advance of referential

language abilities. We recommend that studies of children with brain injuries describe the nature of parental input as well as the child's output to evaluate the importance of the different contributions to the developmental pattern.

This project was supported by a National Institute of Child Health and Human Development grant (No. PO1-HD23388-01A1) and a March of Dimes Social and Behavioral Science grant (No. 12-210). The authors gratefully acknowledge the important contributions of Nancy Wareham, Carol Hallberg, Brain MacWhinney, Mark Scher, Susan Kemp, and James L. McClelland. The authors also thank the family of this child for their gracious cooperation.

REFERENCES

- Aram, D. M., Ekelman, B. L., and Whitaker, H. A. (1986). Spoken syntax in children with acquired unilateral hemisphere lesions. *Brain Lang.* 27:75–100.
- Aram, D. M., and Ekelman, B. L. (1986). Cognitive profiles of children with early onset of unilateral lesions. *Dev. Neuropsychol.* 2: 155–172.
- Aram, D. M., Ekelman, B. L., Rose, D. F., and Whitaker, H. A. (1985). Verbal and cognitive sequelae following unilateral lesions acquired in early childhood. *J. Clin. Exp. Neuropsychol.* 7(1):55–78.
- Basser, L. S. (1962). Hemiplegia of early onset and the faculty of speech with special reference to the effects of hemispherectomy. *Brain* 85: 427–460.
- Blonder, L. X., Bowers, D., and Heilman, K. M. (1991). The role of the right hemisphere in emotional communication. *Brain* 114: 1115–1127.
- Brown, R. (1973). *A First Language: The Early Stages*. Cambridge, MA: Harvard University Press.
- Capute, A. J., Palmer, F. B., Shapiro, B. K., Wachtel, R. C., Schmidt, S., and Ross, A. (1986). Clinical linguistic and auditory milestone scale prediction of cognition in infancy. *Dev. Med. Child Neurol.* 28:762–771.
- Dunn, L. M., and Dunn, L. M. (1981). *Peabody Picture Vocabulary Test—Revised*. Circle Pines, MN: American Guidance Service.

- Feldman, H. M., Holland, A. L., Kemp, S. S., and Janosky, J. (1992). Language development after unilateral brain injury. *Brain Lang.* 42: 89–102.
- Goldfield, B. A. (1987). The contributions of child and caregiver to referential and expressive language. *Appl. Psycholing.* 8:267–280.
- Goldfield, B. A., and Resnick, J. S. (1990). Early lexical acquisition: Rate, content, and the vocabulary spurt. *J. Child Lang.* 17:171–183.
- Goldman, P. S. (1974). An alternative to developmental plasticity: Heterology of CNS structures in infants and adults. In D. G. Stein, J. J. Rosen, and N. Butters (eds.), *Plasticity and Recovery of Function in the Central Nervous System*. New York: Academic Press, pp. 149–174.
- Hendrick, D. L., Prather, E. M., and Tobin, A. R. (1975). *Sequenced Inventory of Communicative Development*. Seattle, WA: University of Washington Press.
- Kiessling, L. S., Denckla, M. B., and Carlton, M. (1983). Evidence for differential hemispheric function in children with hemiplegic cerebral palsy. *Dev. Med. Child Neurol.* 25:(7):27–734.
- Kinsbourne, M., and Hiscock, M. (1983). The normal and deviant development of functional lateralization of the brain. In M. M. Haith and J. J. Campos (eds.), *Handbook of Child Psychology, fourth edition, Vol. II: Infancy and Developmental Psychobiology*. New York: John Wiley & Sons, pp. 157–280.
- MacWhinney, B. (1991). *Manual for Use of the CHAT Transcription Coding System of the Child Language Data Exchange System*. Pittsburgh: Carnegie Mellon University.
- Marchman, V. A., Miller, R., and Bates, E. A. (1991). Babble and first words in children with focal brain injury. *Appl. Psycholinguist.* 12: 1–22.
- McCarthy, D. (1972). *McCarthy Scales of Children's Abilities*. San Antonio, TX, Psychological Corporation.
- Miller, J. F. (1981). *Assessing Language Production in Children*. Baltimore: University Park Press.
- Nelson, K. (1973). Structure and strategy in learning to talk. *Mono-*

- graphs of the Society for Research in Child Development*, 38, Serial No. 149.
- Nelson, K. (1981). Individual differences in language development: Implications for development and language. *Dev. Psychol.* 17:170–187.
- Newborg, J., Stock, J. R., and Wnek, L. (1984). *Battelle Developmental Inventory*. Allen, TX: DLM Teaching Resources.
- Peters, A. M. (1983). *The Units of Language Acquisition*. Cambridge: Cambridge University Press.
- Rankin, J. M., Aram, D. M., and Horowitz, S. J. (1981). Language ability in right and left hemiplegic children. *Brain Lang.* 14:292–306.
- Semel, E., Wiig, E. H., and Secord, W. (1987). *CELF-R: Clinical Evaluation of Language Fundamentals—Revised*. New York: The Psychological Corporation, Harcourt Brace Jovanovich.
- Snyder, L. S., Bates, E., and Bretherton, I. (1981). Content and context in early lexical development. *J. Child Lang.* 8:565–582.
- Thal, D. J., Marchman, V., Stiles, J., Trauner, D., Nass, R., and Bates, E. (1991). Early lexical development in children with focal brain injury. *Brain Lang.* 40:491–527.
- Woods, B., and Teuber, H. (1978). Changing patterns of childhood aphasia. *Ann. Neurol.* 3:273–280.
- VanDongen, H. R., Loonen, C. B., and VanDongen, K. J. (1985). Anatomical basis for acquired fluent aphasia in children. *Ann. Neurol.* 17:306–309.